

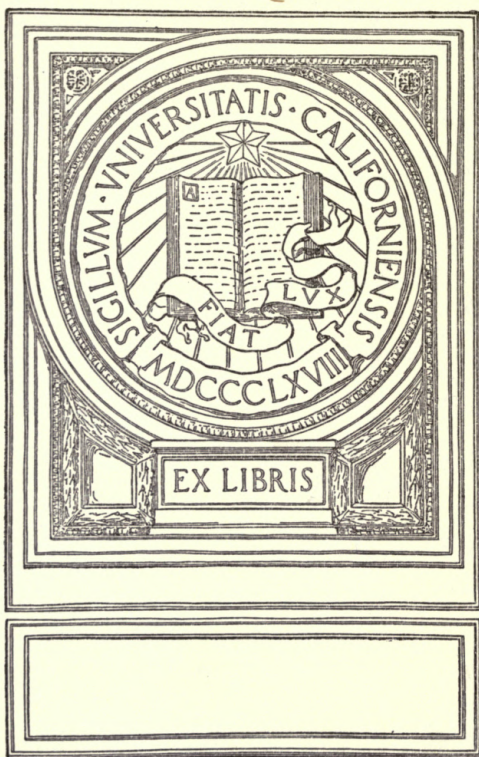
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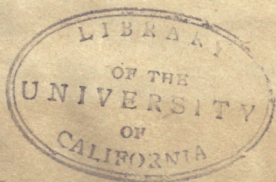
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THE HITCHCOCK LECTURES
OF THE
UNIVERSITY OF CALIFORNIA
1918

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THE HITCHCOCK LECTURES OF THE UNIVERSITY OF
CALIFORNIA, 1918

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[First Lecture]

THE FIRST QUEBEC BRIDGE AND ITS FAILURE

This lecture dealt with the subject of the first bridge erected across the St. Lawrence River just above Quebec, which failed August 29, 1907. It was illustrated by many lantern slides, which traced the history of the structure, explained the type adopted and its relations with other types of long span bridges, discussed the methods of erection of bridges, showed the details of the structure, and finally described its failure and the reasons for this.

This bridge as planned was to have a single span of 1800 feet, the longest span in the world. The main structure was a cantilever bridge, of three spans, located about seven miles above the City of Quebec. The largest span is ninety feet longer than the two spans of the Forth Bridge, which was completed in 1889.

The piers of the Quebec Bridge had been completed and the superstructure of the southerly half was being erected by first erecting the southerly shore arm on scaffolding, and then building out the long span piece by piece by means of travellers. The southerly cantilever arm had been completed and the suspended span in the center of the structure, which is supported at each end upon two cantilever arms, was being built from the southerly end. The heavy traveller at the end of the projecting arm, which had been used in building the southerly cantilever arm, had been removed, and the central supported span was being built with a lighter traveller. A few days before the accident one of the inspectors discovered that one of the lower chord members of the southerly anchor arm near the river pier had buckled or bent out of line about two inches. A deflection at this place had been noticed the previous week, but at that time it was only three-quarters of an inch.

While some of the employees appear to have felt uneasy with regard to this buckling, it was apparently considered by those in charge to be insignificant and not a cause for anxiety. On August 28th a conference of the chief engineers and others in authority was held, and it was decided to place the situation before the consulting engineer in New York. A messenger went to New York for this purpose, and the consulting engineer, after conference, telegraphed Phoenixville, where the bridge was being fabricated, and sent his representative there for consultation with the officers of the bridge company. By the time he arrived at Phoenixville the bridge had collapsed. Eighty-five men went down with the bridge, and of these only eleven were saved.

No such mass of steel work had ever collapsed in the history of bridge building. Some 17,000 tons of steel formed one tangled mass of debris, extending from the anchor pier over the central pier down into the main current of the river.

A study of engineering failures is more enlightening than a study of engineering successes. The lecture discussed the causes of the disaster, and drew the lessons which it taught.

The material and workmanship of the bridge was considered to have been excellent. The disaster was not attributed to any flaw in material or defect in manufacture. It was due to the failure of the compression member and the buckling which had been noticed. This compression member had been designed without taking due account of the actual weight of the structure, the stresses in it were allowed to be too high, and the design was extremely faulty. The lattice bars connecting the parts of the member were much smaller in strength, in proportion to the size of the piece, than those used in ordinary design. These lattice bars had hitherto been designed in a purely empirical manner, although it is possible to apply to them some principles of mechanics. The lecturer, after the failure of the bridge and after obtaining details of the structure, had computed the strength of these columns and had found that failure should have taken place almost precisely when it did.

Facts and figures were given with reference to the details and the causes of the failure, which it is not necessary to discuss further in this abstract.

[Second Lecture] .

THE SECOND QUEBEC BRIDGE

A strange fatality seems to have pursued this structure. After the failure of the first bridge, plans were made for a new one at the same place and with the same span, although the width between trusses was greater. The design of the new structure was radically different from that of the old one, and the differences between the two were explained and illustrated by lantern slides.

The new bridge, like the old, was a cantilever bridge of three spans. The central supported span, which rests on the end of the cantilever arms, which in the old bridge was being built piece by piece from the cantilever arm, was in the new bridge designed to be built complete on the shore of the river. When completely erected, scows were to be run beneath it and the load transferred to these scows, which were then to be towed up the river until this supported span was in position between the two ends of the cantilever arms, which had previously been completely erected, and the supported span was then to be raised by hydraulic machinery into its permanent position.

Great care had been taken in the design of the new structure, and the two cantilevers had been successfully erected without serious accident. The plans for the supported span in the center and for raising it into place had also been carefully studied, and were thought to be beyond suspicion. When the span was being raised, however, after it had been raised a few feet and the scows had been taken away, there was a sudden failure at the southeast corner support, and the entire supported span dropped into the river.

The lecture explained by means of numerous lantern slides the construction of the bridge, the methods of erection, and the causes for the failure. The cause is considered by some to have been a flaw in a steel casting, but it is more probable that the stress in the casting was excessive. Nevertheless, the other three castings held, and it is possible that there may have been a flaw in the

one that failed. The design of these castings, however, was shown to be open to criticism, and the peculiar point was illustrated that while more material was put into them than was necessary the result was a decrease in strength.

Following this failure a new central supported span was built, and in the following year it was successfully erected, so that the structure is now complete. In the erection of the final structure the methods which were considered open to criticism in the previous structure were changed.

[Third Lecture]

RAPID TRANSIT IN CITIES AND THE MEANS OF OBTAINING IT

This lecture dealt with the subject of the growth of urban population, the transportation problems to which this growth had given rise, and the methods of meeting these problems. The lecture was illustrated by a large number of lantern slides showing subways and elevated structures in various American and foreign cities.

The two main methods of providing rapid transit in cities are by means of subways and elevated lines. The first subway in the United States was built in Boston, and the lecturer had been connected as a member of the Boston Transit Commission with the construction of all the Boston subways for the previous twenty-five years. The relative advantages and disadvantages of subways and elevated lines were discussed, the relative costs compared, and the methods of construction described.

[Fourth Lecture]

THE PRESENT SITUATION WITH REGARD TO THE DEVELOPMENT OF WATER POWER AND FEDERAL LEGISLATION ON THE SUBJECT

There are few points of more practical interest to the people of this country than the development of water power. In this subject the people of the Pacific Coast should be particularly interested, inasmuch as they are comparatively remote from

deposits of coal, although, of course, they have large supplies of that other fuel, which has taken so large a place in industry in recent years.

Power is one of the great necessities of modern civilization. Indeed it may fairly be said that this modern age may be characterized more accurately than in any other way as an age of the development and use of power. When we remember that it is only one hundred and fifty years or less since the invention of the steam engine, that the locomotive is not yet one hundred years old, that the telephone, electric light, all forms of electric energy, and practically all of our modern machinery have been developed within one hundred and fifty years, prior to which time almost all manufacturing was done by hand, is it not clear that this is an age primarily of power and machinery?

The sources of power are two, viz.: the combustion of fuel, and the harnessing of the natural power developed by falling water. These two sources are fundamentally different in their economic significance. Every pound of fuel that is burned is permanently lost to mankind and can never be recovered. Conservation of fuel means economy and restriction in its use. Seeing that the end of our fuel supplies must come at some time, perhaps in the not very distant future, it is essential that the greatest possible economy should be exercised in its use. The power of falling water, on the other hand, is generated constantly by our rivers as they flow from their sources to the sea, and only needs to be harnessed in order to be utilized. Every pound of falling water *not* harnessed or used is lost forever and can never be recovered, although providentially the power goes on perpetually from year to year, renewing itself constantly.

Conservation of fuel, therefore, means the greatest possible *restriction* in its use: conservation of water power means the greatest possible *extension* of its use. Every horse power developed by water not only provides that power for use, but eliminates development of power by means of combustion and permanent loss of fuel. Conservation of water power is therefore a double conservation; it saves not only the power itself, which otherwise runs to waste, but it prevents or replaces the development of power by the use of something which once used can never be replaced.

There is a third element involved, which makes the use of water power a triple conservation. Much has been said in recent years with reference to the desirability of improving our means of inland navigation by making our rivers navigable. In general this can only be done by means of locks, dams, and canals, by which a river is converted into a series of pools, or reaches, in which the velocity and depth are sufficient for navigation. Most projects for inland navigation are, in the opinion of the speaker, uneconomical and undesirable. Transportation by river and canal has been outgrown and superseded by transportation by rail, except in certain special localities, as, for instance, on the Great Lakes and wherever long distances can be traversed by water by means of large vessels. If anyone doubts this he has only to read Professor Moulton's interesting book entitled "Waterways vs. Railways," or Mr. John Howe Peyton's book on railroad transportation in order to be convinced. Nevertheless, much is said about inland navigation, and in some cases and for small craft it is a desirable means of transportation. The point now to be observed is that the development of water power by the building of a dam is a large step in making a river navigable. The dam should, of course, be located not solely with reference to the requirements of water power but also with reference to the requirements of navigation. If so located, a water power development is a navigation improvement. Conservation of water power, therefore, not only develops power and prevents it going to waste, but also conserves fuel and navigation, and is, therefore, a triple conservation. At the present moment with the enormous demand for fuel, its price is very high, and the supply is insufficient for daily requirements. In the East there has been a coal famine this winter, the seriousness of which is probably not appreciated by those who live in the warm climate of California. Many people have been unable to get coal enough to keep themselves decently or comfortably warm through a winter of unexampled severity. The coal supply has been doled out in basketful or bagful under the direction of public committees, and our coal yards have every day been crowded with anxious people trying to get a few pounds to keep themselves warm. An ex-mayor of the city in which I live, finding himself out of coal and trying to get some was told by his dealer that the best he could

do was to let him have one ton if he would send and get it. Some people have had to close up their houses and live in hotels. Factories have been obliged to restrict output at the very time when it should have been increased to its maximum. Even in Philadelphia, close to the coal deposits of Pennsylvania, there has been much suffering and distress.

The situation indicates forcibly the need, in the interests of the public and of the nation, of the greatest possible or practicable development of water power, for water power can be used not only for power but for heat and light. Moreover, the introduction of electrical transmission of power has made it possible to develop water power in inaccessible regions, where such power exists, and to transmit it for use up to a distance of over two hundred miles with very little loss in transmission. Previous to the development of electrical transmission water power was under the great handicap that it could only be used at or near the point of development which is frequently in remote, mountainous, or otherwise inaccessible regions. Electrical transmission has, therefore, revolutionized the status of water power and enormously increased its importance. With the development of electrical transmission has also come the increasing use of electricity as a means of utilizing power. Electric light has become the almost universal illuminant and electric motors are universally used to drive our street cars and largely used to drive machinery in mills. One of the great developments in the future will be its increased use in operating our railroads by means of electric locomotives instead of steam locomotives. Electric power is also used in many commercial processes, such as the manufacture of nitrogenous products for explosives and fertilizers, and in other processes requiring the production of a high temperature.

In view of all the foregoing, it seems passing strange that water power has not been utilized to a greater extent. It would seem self-evident that the interests of the public would require its greatest possible economic development. Notwithstanding this its development has lagged behind that of steam. The last census of the United States in 1909 showed the total owned steam and gas power in use in forty-three leading industries to be 14,950,525 horse power, and the total water power in use 1,822,888 horse

power. Mr. Leighton, formerly Hydrographer of the United States Geological Survey, states that the developed water power, according to the census made in 1908 is 5,356,680 horse power. Mr. Leighton estimates that the undeveloped water power amounts to 37,000,000 horse power for twenty-four hours a day and 365 days in the year, of which one-third is in the northern Pacific region. Another government estimate is 28,000,000 horse power. But the greater part of the undeveloped power is at sites where at the present time there is no market. Mr. Leighton further states that in his opinion "The available water power sites in the country are all developed." It should be remarked, however, that the electrification of our railroads would make available a great many sites where otherwise there would be no market. Moreover, many sites now developed might have the power much increased if provision were made for proper storage which would supply water during dry seasons. The increase in power available by this means is very great, the absolute maximum power possible by development in this country amounting in Mr. Leighton's opinion, to "a conservative total of at least 200,000,000 horse power."

There is no question in the minds of those who have given this problem careful consideration that there is in this country an immense supply of water power possible of commercial development if a market could be established, and that the electrification of railways and the development of electro-chemical industries may offer a market for much of this power. A large part of the power within range of commercial development is in the region of the Columbia River and the northwestern Pacific slope. It is stated by good authority that "The largest amount of water power in any one state is contained in the state of Washington, which has nearly 10,000,000 water horse power, of which less than three per cent has been developed. In Washington coal is mined and steam power plants are operated within the range of the sound of descending waters, and trainloads of coal are imported each day from British Columbia." The same authority gives a list of actual projects for the development of water power in navigable streams which have been held back from development, amounting to 2,122,000 horse power. At all events a very great amount of power is possible of development

as an engineering proposition, and in view of the fuel shortage its development and use should be carefully studied and encouraged in every reasonable way.

This subject has within the last three months been taken up by the Chamber of Commerce of the United States through a committee appointed for the purpose, and a referendum has been issued to constituent members throughout the country briefly discussing the subject and asking for a vote on certain fundamental principles involved.

In a recent consular report on the chemical industries of Norway the following statement is made:

In surveying the chemical industries of Norway there are several features worthy of careful study by the American economist. First and foremost is the systematic and exhaustive manner in which the abundant water power of the country is now being regulated, stored up, and pressed into the service of the steadily increasing group of the electro-chemical industries. The best talent of the nation is enlisted in this cause and the way is rapidly being opened for Norway to assume an industrial position commensurate with its size and admirable facilities for maritime transportation.

Why should not the United States devote equal attention to the development of its great resources?

From the above figures and other available statements and estimates it seems probable that there is today in use between four and five times as much steam power as water power, and that there is still undeveloped water power which could be practically developed amounting to much more than all of the steam power now in use.

The development of water power besides saving fuel and affording a means of improving navigation, would bring other important advantages. It would release for other service the labor of millions of men employed in mining, transportation, and distribution; it would release hundreds of thousands of freight cars now used in transporting coal, as well as thousands of locomotives; it would save much damage and inconvenience due to smoke and soot, and thereby tend to improve human health and cleanliness.

Every horse power than can be developed by water and used to replace steam power saves in the neighborhood of \$15 worth of coal per annum. If this saving is capitalized at ten per cent it justifies an investment of say \$150 a horse power in a water

power plant in excess of a steam plant. If 10,000,000 horse power could be developed by water this justifies an investment of \$1,500,000,000. There seems little doubt that at least 5,000,000 horse power could today be developed by water if encouragement were offered. This would mean an annual saving of, say, \$75,000,000 in cost of coal alone.

Mr. Hugh L. Cooper estimates that the utilization of 35,000,000 horse power by water power would save, as compared with steam power, the sum of \$1,241,600,000 per annum, besides conserving 280,000,000 tons of coal and transferring to other needs the service of 600,000 railway cars, 20,000 locomotives, and 740,000 laborers.

Why then has water power not been more developed? There are two reasons; first, the high cost of development of water power and its inferiority to steam in most respects; second, governmental restriction and discouragement. Let us consider these two in some detail.

1. High Cost of Development of Water Power and Its Inferiority to Steam in Most Respects

One of the fundamental mistakes in the popular conception of water power is that it is cheap. The power itself is observed running to waste and it is inferred that as the power is there and does not require to be developed but only to be harnessed, it can be utilized at small expense. Such a view is incorrect.

No power plant would be built, whether for steam or water, except in the expectation that it would be profitable for its owners, that is to say, that the gross return would be sufficient to cover all charges and leave a net return of an amount sufficient to be attractive.

With reference to the cost of power the charges to be deducted from gross earnings are five, viz.: fuel, other operating expenses, taxes, depreciation, and fixed charges. A water power plant has the advantage that there will be no charge for fuel, and that other operating expenses will be small. The taxes and depreciation will be perhaps the same in either case, though the depreciation should be smaller, in general, for a water power plant. The fixed charges, however, will be very much greater for the water power

plant. It is not generally realized that the initial cost of a water power plant will generally be from two to five times as much per horse power as for a steam plant, and, furthermore, that the initial development will have to provide for a larger total horse power. This arises from the fact that the construction necessary for a water power plant frequently, or generally, involves a dam, which may be of great size, and a very large area of land which must be flooded, and riparian rights acquired, together with canals, pen stocks, flumes, or conduits, and sometimes of great length, as well as transmission lines many miles in length, all of which is in addition to the power house itself with its necessary machinery. A steam plant is simple, involving simply the buildings and land for them, with the necessary machinery. The risk to the investor on account of the greater initial cost and higher fixed charges is, therefore, much greater for the water power plant than for the steam plant. Moreover, in case of failure there is a greater salvage in the steam plant. The land and buildings may be abandoned and used for other purposes, for they are generally located near the point of utilization or in a city, whereas a water power plant, like a railroad, can only be used for the purpose for which it was designed and cannot be abandoned and given up to some other use. The investor in a water power plant must, therefore, be prepared to face fixed charges of from two to five times that of a steam plant per horse power; and this of itself would be sufficient to deter investors from entering this field unless favorable conditions should exist both as to development and utilization and freedom from undue interference by public authorities. Furthermore, as already stated, the initial development in a water power plant must be greater relatively than in a steam plant. Most undertakings grow from small beginnings. If steam power is used, a small power plant may be built first, with one boiler and one engine. If the undertaking is successful and the demand for power grows, it is easy to add more units. In a water power plant, on the other hand, the dam, reservoirs, tunnels and other conduits, must be planned for a greater capacity than will be available at the beginning, for it may be difficult, if not impossible, to increase the capacity. The turbine wheels, of course, may be increased

in number as the demand for power increases, but the other elements, except the transmission line, are not so easily increased. This element then also increases the initial investment and the risk to the investor. There is still another advantage in a steam plant, arising from the relatively greater possibility of improvement in the efficiency of steam machinery. A water wheel will utilize eighty or more per cent of the theoretical energy of the falling water, and the loss in electrical transmission will be small. There is, therefore, only a possibility of a slight increase in efficiency due to improvements in the art, probably not over five to ten per cent. On the other hand, in a steam plant the best reciprocating engines or steam turbines develop but little more than fifteen per cent of the theoretical energy of the coal and the best gas engines something over twenty per cent. It is evident that the margin for possible increase in efficiency is very great. As a matter of fact, notwithstanding the increase in the cost of fuel, both the initial cost and the operating cost of steam plants has decreased considerably within recent years. Not many years ago a steam plant was commonly estimated to cost in the neighborhood of \$100 per horse power, while recently (before the war, of course) large plants have been built at an initial cost of \$40 or \$50 per horse power, and these plants are said to have generated power for about three and a-third mills per kilowatt hour exclusive of interest and depreciation, which means for constant power twenty-four hours a day and 365 days in the year about \$22 per horse power. If to this we add twelve per cent, on \$40, for interest and depreciation on the initial cost, we arrive at a total cost under \$27 per horse power per annum under favorable conditions, but varying, of course, very greatly, depending upon the manner in which the power is used, whether constantly or only during the day, the cost of fuel and labor, whether steam is needed and used for other purposes, as for heating, processes of manufacturing, etc.

Moreover, steam power is constant from day to day throughout the year, while water power fluctuates, sometimes very greatly. At periods of low water there may be very little power, while at other times there may be a disastrous flood. The works are liable to damage, and if the power to be developed is to be

greater than the absolute minimum flow of the stream it must be by storage, which can only be procured by means of reservoirs, involving the taking and flooding of large areas.

Water power can be produced aside from fixed charges at a lower cost than steam power, if the conditions are favorable, owing to the absence of cost for fuel and the lower cost for labor; but the fixed charges on the much larger investment often suffices to bring the total cost above that for steam power.

Summing up, the large initial cost of water power developments and the greater risk to the investor, together with the greater proportional development required at the beginning, is the main deterrent under this first heading to water power development. Once safely financed and in operation, with a good market, and fair treatment, water power developments are very attractive on account of the greater convenience, the small operating expense, the small amount of labor employed, and the consequent absence of labor troubles, the independence of fuel supply, the smaller depreciation (in general), and the comparatively small amount of working capital needed. These advantages, however, may be more than offset if burdensome regulations and restrictions are likely to be imposed by public authority.

It is a common impression that water powers are very profitable undertakings, which are being sought by capital as a means of securing large returns on a small investment. Such is not the case. It has been pointed out that the investment is large and that in many respects steam power offers greater possibilities for profit than water power. If water power is to be developed, the conditions must be made favorable, and inducements must be offered to investors, including reasonable assurance of fair treatment from the public authorities. Present demand for the development of water power—and there is a large demand in many localities—generally comes not from capitalists who are seeking for profitable investment, but more often from communities and industries which, on account of the high price and scarcity of fuel, are desirous in their own interest of inducing capital to make such developments; just as the demand for the building of railroads in the early days arose quite as much, if not more, from the desire of communities and states to secure

transportation facilities in order to develop the public resources as it did from investors who saw the possibilities of large returns.

The collateral advantages resulting from the development of water power, viz., the saving in fuel, in labor, in transportation, the absence of smoke and soot, are reaped not by the owners of the water power but by the community as a whole. If the total water power in the country now commercially capable of development could be brought into use, there is no question that the total direct and indirect saving to the public in the conservation of fuel and the release of labor and railroad equipment, as well as in other ways, would run into hundreds of millions of dollars annually, perhaps billions of dollars.

The above considerations show the importance of approaching the subject with an attitude of mind which recognizes that the development of water power is of benefit mainly to the community as a whole, and that in order to secure such benefits water power developments must be made attractive to capital, rather than with the attitude of mind which assumes that such enterprises should be surrounded with as many restrictions as possible. Particularly is this the case at this moment in this country. Capital will have abundant opportunities after this war, both here and abroad. States, communities, and individuals will be clamoring for it, and it will be comparatively scarce, owing to the great destruction of wealth which has taken place. There will also be a scarcity of labor unless the labor supply of Oriental countries, which have not felt the devastation of war, can be utilized, which seems to many desirable though it may not appeal to some of you on the Pacific Coast.

This leads us to consider the second reason why water power has not been more extensively developed, viz.,

2. Governmental Restriction.

It is self-evident that large water powers will generally exist on large streams on which navigation is possible and which come within the category of navigable streams, or else in regions near head water which may lie within the public lands of the Forest Reserve. It is stated on good authority that of 77.2 per cent of the water power resources of the country which require a Federal

permit, less than 4 per cent has been developed, while of 22 per cent of those resources which do not require a Federal permit 25 per cent has been developed. (This, of course, may be partly due to inaccessibility, lack of market, etc.) As a matter of fact many undeveloped water powers are in whole or in part under control of the Federal Government, either because they are on navigable streams or require the use of public lands. With respect to these powers the policy of the Federal Government in recent years has been such that their development, instead of being encouraged, has been almost prohibited. I will endeavor to briefly summarize the situation.

Federal Acts prior to 1899 had prohibited the building of dams in navigable rivers in such manner as to obstruct or hinder navigation or in places where they might interfere with actual navigation until the plans for such works should be approved by the Secretary of War. In 1899 an act was passed requiring the consent of Congress for the building of such structures and the approval of the plans by the Chief of Engineers and the Secretary of War. Since the passage of this act it has been customary to obtain a special act of Congress for the development of each water power on navigable streams. These acts generally require very properly that any changes which may be rendered necessary if the structure is found to obstruct navigation in the future shall be carried out by the owners at their own expense.

In 1906 the so-called General Dam Act was passed, in which further restrictions were added, requiring the permittee to construct, maintain, and operate at his own expense such locks or other structures or appliances which the Secretary of War at any time might deem necessary in the interests of navigation, and that if Congress should authorize the construction of a lock for navigation in connection with a dam, the owner should convey to the United States, free of cost, the title to such land as might be required, and should operate such locks, and maintain such lights and signals, at his own expense, as the Secretary of Commerce and Labor should prescribe. These conditions were not obligatory, but they *might* be imposed by the Secretary of War at his option, although another section of the act allowed the United States to construct and maintain locks or other struc-

tures required for navigation at its own expense. The main objection to the act, however, was that it was revocable by the Government at any time. In 1910 the act of 1906 was amended and still further restrictions added, providing for the collection of a charge for any head-water improvements made by the United States which might improve the flow of the stream, even though the permittee did not profit by them. Any act was made revocable at any time, but, if revoked, the United States was to pay the owners the reasonable value of the works, as decided by the court if not by agreement. Permits were to be given for a period not exceeding fifty years. This last act was, therefore, more fair to the permittee than that of 1906, because it provided that if the rights should be revoked the owner should receive compensation. It did not, however, provide for any compensation at the end of the period of the lease, which could not be greater than fifty years, nor for any renewal at that time. The owner, therefore, who developed the water power would have to amortize or receive back his entire capital during the fifty year period.

It will be observed that by this last act the permit was revocable at any time: if revoked the United States was to pay compensation, and had a term not to exceed fifty years, without compensation or renewal at the end of that period; also that the permittee might be required to give land for locks and to construct and operate such locks at his own expense. Notwithstanding the fact that by constructing the dam he made a large contribution toward rendering the stream navigable, he was required, or might be required to contribute still more. There was no question as to the propriety of his paying for any benefit which he might receive from head-water improvements, if he actually received it. The government also reserved the right to alter and amend the act at any time. Any riparian owner building a dam for power purposes, therefore, placed himself entirely at the mercy of the Federal Government. But even these restrictions were not sufficient for those entirely well-meaning and enthusiastic persons who maintained that the government should not give away any of its rights on navigable streams or on the public domain, but who failed to perceive the importance of encourag-

ing water power development. They maintained that, in addition, the permittee should be charged for the power developed. They insisted on the imposition of such charge, together with the other burdens referred to, being placed upon riparian owners who desired to utilize their natural riparian rights and incidentally to confer a considerable benefit upon the government without expense to it by improving the navigability of the stream. Several bills providing for the construction of dams across navigable streams were vetoed in 1908, 1909, and 1912, because they contained no provision for compensation, or because the act of 1906 did not terminate the permit at some fixed time. There was great difference of opinion in Congress regarding these matters, and in general it may be said that Congress was in favor of greater liberality toward permittees, while the executives believed in restriction. In 1913 a bill to permit the construction of a dam for water power purposes across the Connecticut River, which provided for compensation to the government, to which the applicants for the privilege had agreed, was defeated in Congress by the votes of those who were willing to give the company the privilege without compensation but were unwilling to establish the precedent or to recognize the principle that the government is entitled to receive it. They believed that while it had the power, it had not the legal or moral right to accept it.

Prior to January 30, 1912, the Federal Government expended at the Des Moines Rapids on the Mississippi River the sum of \$1,458,103 for inadequate navigation facilities, and prior to June 30, 1912, the sum of \$12,184,987 for navigation improvements on the entire stretch of the river between the mouth of the Missouri and St. Paul. Since 1910 the Mississippi River Power Company as a private investment has expended upward of \$20,000,000 at the Des Moines Rapids, and has constructed a magnificent dam with locks of deep draft.

On the Coosa River in Alabama, which is navigable in its upper and its lower portions, but not in an intermediate distance of about one hundred miles, in which improvements by the government have been considered impracticable on account of the expense, navigation improvements had cost prior to 1876 about \$1,500,000. Under an act of 1907 a water power dam has been

constructed without expense to the government at a cost of over \$2,000,000, and in 1912 a similar improvement was proposed at another place at nearly the same cost. This was vetoed because no compensation was provided. In this case the applicants proposed to build a nitrate plant, producing a product valuable for fertilizers or explosives. If this bill had not been vetoed, this country would have had a nitrate plant today. As it was, when the permit was refused the applicants went to Canada and located their plant there.

Similar restrictions have been urged upon the government and adopted with reference to the development of water power on the public domain. Here it is, of course, proper that if government lands are used the permittee should either pay for them outright or pay a reasonable annual charge. Where, however, the public domain is only incidentally affected, as, for instance, where some portion of it would be flooded by the pond created by the dam, or where government land is crossed by flumes or transmission lines, if water power development is to be encouraged it is desirable that the permittee should acquire a permanent right or that, at all events, he should not be subjected to any onerous restrictions. This case, however, according to present regulations is treated just the same as the case where the government owns the site of the power itself. The main obstacle to development in these cases does not arise from the rates which are charged, which are generally reasonable, but from the form and condition of the permit, which at present is revocable at any time at the will of the government department by which it is granted, and also subject to other deterrent restrictions. Can you imagine that investors will knowingly put their money into water power developments if the fact that a small part of the transmission line which may lie upon government lands subjects the entire development to the charge of instant revocation of its rights upon the whim of a cabinet officer? As a matter of fact, on March 2, 1909, the Secretary of Agriculture and the Secretary of the Interior did revoke some twenty-five permits, substituting permits with different conditions. It may be that the revocations in this case were not made for the purpose of embarrassing the permittee, but were to meet altered conditions; but the fact

remains that permits could be revoked and have been revoked at the pleasure of a cabinet officer, and that the revocations made did embarrass the permittee.

Among the other provisions with reference to water powers on the public lands which hinder the development of power are the following: If the government takes the property, the price paid is to be fixed by the government or by a member of the cabinet. It is sometimes provided that a company operating under a government permit shall not sell more than fifty per cent of its power, or some other percentage, to any one concern. How could railroad electrification be promoted under such restrictions? Rental rates, which, as we have stated above, are properly imposed, may be revoked by the Secretary and new ones imposed at periods of not less than ten years. In imposing new rates, appreciation in land values is considered as income in estimating a fair return to the investor, who, of course, never receives this appreciation, since the land is used and necessary for the works. Notwithstanding this, in case the property is taken by the United States or by state or municipal corporations only the original cost of the tangible property is to be paid to the owner. He is here *not* to be allowed the appreciation of land.

The inadequacy of the present laws to encourage water power development has been recognized by several cabinet members directly concerned, who have referred to them as "absolutely inadequate and thoroughly unsound in principle and practice." Please remember, then, that the present defects of water power legislation may be summed as follows, as outlined in the report of the committee of the Chamber of Commerce of the United States:

Water Powers on the Public Domain

As to water powers on the public domain (lands the title to which is in the United States),—a permit has to be obtained from the Department of Agriculture or the Department of the Interior, whichever has control over the site in question, and, no matter how much the investment required, the permittee must accept a permit which is upon the face and in fact, arbitrarily revocable at any time,—that is, revocable by the same department that grants the permit. His permit also may be made subject to any conditions which the department may see fit to impose at the time the permit is granted. But this is not all, for his permit is made subject to any further condition which the same department may at any time choose to impose, adding further burdens or restrictions even after

his investment has been made. Indeed, if a homesteader happens to make entry upon the land covered by the site occupied by the investor's water-power plant, then immediately the permit is, by virtue of such entry, automatically revoked. And in neither case is the investor protected by provision for compensation. His entire investment is at the hazard of loss or confiscation from the moment it is made.

Again, even if the water-power site is located outside of the public domain and it becomes necessary to use or cross any part of the public domain for a transmission line or otherwise, then, no matter how slight the use, a permit must be gotten for such use, and the same hazard of revocation prevails as in the case of a permit for a public domain site.

The result is that, out of about 5,000,000 kilowatts of energy commercially feasible to be developed from the water powers upon the public domain, only about one-tenth have been developed. 4,500,000 kilowatts of energy on the public domain are unnecessarily and unreasonably allowed to continue to waste, because the legislative restrictions and hazards prevent the necessary investment of private capital.

Water Powers on Navigable Streams Outside the Public Domain

Under the present status (Acts of 1906 and 1910) applying to water powers outside the public domain, the term of the permit cannot exceed fifty years, and at the end of that time the permittee has no rights whatever. No consideration is taken of the length of time required to build up his business and to get on a profit-paying basis, nor of the necessary investment to keep his plant up-to-date. At the end of the 50-year term, or a shorter term if it were made shorter, he must lose his entire investment. To save himself from this loss he must amortize his plant, which is impossible; that is, he must add to his charges for service such amounts, beyond the otherwise ordinary charges necessary to bring a fair profit, as are sufficient to pay him back by the end of his term his entire investment. In many instances this would make his charges beyond the rate which would bring a demand for his service.

But this is not his only hazard. His permit may be arbitrarily revoked at any time before the end of his term, and that, too, without compensating him adequately for his investment. Moreover, arbitrary conditions at the will of the War Department may be imposed, and the nature and extent of the burdens or hazards which may thus be arbitrarily imposed are left indefinite and uncertain. Furthermore, he is subject to such conditions not only imposed at the time and as a part of his permit, but it is also subject to other indefinite and uncertain conditions and burdens which may be imposed subsequently thereto.

This makes it impossible for any investor, acting under such a consent of the Congress and a permit issued thereunder, to compute with any business-like approximation the amount of the investment which he may ultimately be compelled to make. Of course, where the investment-cost per horse power produced exceeds a fixed sum, varying under various conditions, the enterprise is not commercially feasible; that is, development and operation mean a loss of profit and a loss of investment. These water-power developments require large capital and careful financing, all of which is impossible in the face of these uncertainties and hazards before which capital necessarily shrinks. There have been developments on

navigable streams within the past few years, but none of these has been made under any permit granted under act of Congress since 1907. These developments are under consents granted under prior acts.

These are the reasons for the present stagnation of water-power development on navigable streams in this country. The legislative defects now existing are apparent and not denied by any sane student of the subject.

The present administration appears to recognize the difficulty and is endeavoring to deal with it. The Committee of the Chamber of Commerce of the United States, as above stated, has prepared a referendum. This committee has made the following recommendations:

1. As to all developments, whether within or outside the public domain, a separate act of Congress should not as at present be required for each development; but the authority to issue permits should be vested in some department or commission designated for that purpose and under conditions protective of the interest of the public and of the investor.

The advisability of this action has been generally recognized by most students of the question.

2. Permits should be issued for a period of at least 50 years, unless at the option of the applicant a shorter period is agreed upon, and should be irrevocable, except for cause.

It will not be sufficient to fix the term of a permit as "not exceeding 50 years." This would allow the government authority to dictate a shorter period. Capital investments in water power development should be allowed at least a 50-year period in order to insure a reasonable average annual return, making up in later years for losses incurred throughout the period necessary to build up the business. A 50-year period is recognized very generally among financiers as the shortest reasonable period for such an investment.

3. A toll should be imposed by the government only on power developments on the public domain or benefited by head-water improvements maintained by the government. Such tolls should be based upon the horse power actually developed, used, and sold. The tolls should be reasonable, and proportionate to the benefits actually derived.

A distinction is not always recognized, as it should be, between tolls exacted for permits for sites on the public domain and those exacted under permits to develop power on navigable streams outside the public domain. Tolls, as such, exacted for the purpose of revenue, are not justifiable in reason or, according to

good authorities, in law when imposed under permits for the improvement of navigable streams outside the public domain.

The government owns the public domain and when it grants a permit for a site on the public domain it may reasonably exact a toll, but a permit for a development upon a navigable stream not on the public domain is simply a permit to improve riparian rights owned by the applicant, and the sole justification for even requiring a permit in such a case is to protect the paramount right of the government to regulate and protect navigation. On such streams, therefore, a toll, if exacted at all, should be simply in the nature of a license fee to cover the cost to the government of such control and inspection of construction and operation as are necessary to protect the interests of navigation.

In case the government makes improvements at the headwaters of the stream, which improve its flow, and is, therefore, beneficial to water powers below, it is proper that the amount of such actual benefit received should be paid back, in part at least, by all the users of water power, in order to reimburse the government to some extent for the operation of the headwater improvement. It is to be observed, however, that navigation interests benefit by such headwater improvements equally with water powers and perhaps more so, and that this benefit is given without charge to those who profit from the navigation facilities. for the federal policy regarding navigation is stated by the act of February 27, 1911, as follows:

No tolls or operating charges whatever shall be levied upon or collected from any vessel, barge, or other water craft, passing through any lock, canal, canalized river, or other work for the use or benefit of navigation now belonging to the United States or which may be hereafter acquired or constructed.

It is difficult to see why, in view of this provision, any toll, even for headwater improvements, should be levied upon users of water power; for it discriminates against them in comparison with navigation interests, while, as a matter of fact, the development of water power is much more beneficial to the public and ought to be much more encouraged than the development of inland navigation.

Any toll levied for headwater improvements should be accurately defined. If stated as so much "horse power per annum"

it is uncertain whether it is to be based on the number of potential horse power possible of development at the site, whether or not developed, utilized, or sold; or whether on the basis of the actual horse power generated at the site as a matter of fact, without reference to the quantity utilized; or again, whether upon the power actually developed, used and sold. The latter basis alone should be the proper basis of the toll. The owner of the site might have at his disposal already much more than he could find a market for, and any headwater improvements might simply result in a greater flow of water over his dam, without benefit to him. Why, then, should he be taxed for such headwater improvements, which he has not asked for, does not desire, and cannot use?

4. If public lands form only a small and incidental part of the entire development, the licensee should be entitled to acquire the right to use such lands, paying the government fair and just compensation for such use.

One of the greatest obstacles to development of water power on the public domain in cases where it is necessary for a transmission line or pipe line to cross a small portion of government land, but in which the site of the power itself is not on the public domain, is the impossibility of obtaining any assurance from the government that he can get the necessary rights, under any reasonable tenure, which will assure him of security in his investment. Any such slight use of government lands which may be necessary to his enterprise may under present regulations result in arbitrary revocation of his entire permit, and may, therefore, mean the destruction of his entire investment.

5. At the expiration of the license period the government should have the right to recapture the property for itself or for a new licensee upon the payment of fair and just compensation for the property and for all dependent property, if taken; and if the dependent property is not taken, then fair and just compensation should be paid for all severance damages.

Provision should be made that, all things being equal, the original licensee have priority over any new licensee.

No great development of water will take place unless the rights of permittees at the expiration of the permit are properly protected. It seems clear that the government should have the power to recapture the property at that time by paying for it its fair value at that time. It should not have the power to take a

portion of the entire property, leaving to the owner a portion which is vitally dependent upon the portion taken by the government, unless fair compensation is paid for the damage thereby sustained.

6. At the expiration of the license period the government should (1) agree with the licensee as to the terms of a new license, (2) recapture for itself or for a new licensee, or (3) continue the license under the original terms.

If the government does not desire to take over the property at the expiration of the license it is clear that it should be obliged either to continue the license under the original terms or agree upon new terms with the old licensee. It should not have the power to force the old licensee to accept its own terms.

7. Rates and services should be regulated by state commissions where the service is intrastate, and only by federal authority where the service is interstate and the commissions of the states which are directly concerned do not agree or there is no state commission.

The exercise of any federal jurisdiction over the issuance of securities would be unnecessary and unwise.

8. No preference should be allowed as between applicants, whether a municipality or otherwise, which amounts to the granting at the expense of the government of a subsidy creating unequal competition in the same market.

Some bills relating to this subject have proposed that municipalities or states should be granted permits without charge while private parties must pay a toll. This would make it possible after a private company had developed a power and was selling it, for instance, for electric lighting purposes, for the municipality to develop another power and enter into competition with the existing company, not only for municipal purposes but for private purposes, which might result in the ruin of the original company. It should not be possible for such a condition to arise. It would mean putting into the market a competitor subsidized at the expense of the government. It would mean that a private licensee would under a government license expend time and money to build up a market and business and when, perhaps after a long period, the time for making profits began then the government would under another license give to a municipal corporation, free of cost, other power with which, as a competitor, to enter into a market already built up under burdens of expense imposed by the government. There would be

competitors in the same market, the one under the burden of expenditure imposed by the government permits, licenses or leases, and the other subsidized either by a remission of capital expenses or of tolls and, therefore receiving free of cost the benefits of improvements paid for by the government.

In view of the benefits to the community which are brought about by the development of water power, it is earnestly to be hoped that action will soon be taken by Congress which, instead of restricting, will encourage to the greatest possible extent the investment of capital in these enterprises. Without any interest in any of them and looking at the subject purely as a student of public policy, the speaker has become convinced, especially in view of the developments during this war, that it will be better for the Federal Government to pay a subsidy to encourage the development of water power and to remove all restrictions so far as possible, always reserving to the government the power to take over the property at any time in the future at its fair value at such time. Perhaps when that time comes the courts will have finally decided what fair value is, and how it is to be determined.

[Fifth Lecture]

SOME CONTROVERSIAL POINTS IN THE VALUATION OF PUBLIC UTILITY PROPERTIES

The subject of the valuation of public utilities and other properties has come prominently into the public eye within two or three decades. It has led almost to the formation of a new branch of engineering, and has attracted the attention of many economists and publicists.

The problem of estimating the value of an industrial property is of course old. Bankers and business men have for many years been obliged to attack it in order to form an opinion which would justify purchase or sale, or the flotation of new securities, particularly since the era of industrial combination set in. But the great increase in interest in the subject has been mainly the result of the increasing regulation of public utilities by state and national regulating commissions. When it was decided that

public authorities could fix the rates to be charged by public utility corporations, the question naturally arose at the outset, upon what sum should the company be allowed to earn at least a fair return? When it became necessary for a public board to decide upon new issues of capital, or upon the proper total capital to be allowed the company or upon the price to be paid for a taking, the question naturally arose, what is the fair value of the property represented? When it became necessary to allow a company to earn a certain depreciation allowance, it was naturally at once queried, upon what value shall such allowance be reckoned?

However, it is easy to go too far in the application of any theory. There is clearly no relation between any particular railroad rate, as, for instance, that between San Francisco and Chicago, and the value of the property. The rate between competitive points must be the same by all roads, independent of value. The most that can be said of railroad rates is that if the earnings as a whole, over a large district, are not sufficient to give a fair return on the total value of the property, they should be increased, and *vice versa*. Yet even here, some roads, by virtue of low cost of construction or exceptional efficiency of management, may prosper on the old rates, while other roads may become bankrupt. The limits for the use of a valuation at all is a subject for careful consideration. We are in danger of forgetting that, in the words of Jefferson, "That country is best governed which is least governed." May it not be that we are regulating too much, and forgetting that after all, the principle that rates should be determined by what the traffic will bear, rightly applied, is perhaps the best? At all events, this principle has been the one under which our railroad system has mainly developed, and it has developed business and given us lower rates and better service than in any other country on earth.

It is very generally assumed that the courts have decided that a railroad company, or any public utility company, shall earn no more than a fair return upon its property. This, however, is not my understanding of the situation. I do not understand that the Supreme Court has ever established that doctrine. The function of that Court is only to decide whether any action violates the

Constitution of the United States, and in rate cases to decide when a rate is so low as to result in confiscation of private property. In exercising this function I understand that it has decided that one criterion by which to decide whether rates fixed by legislative authority are so low as to deprive a railroad company of its property without just compensation, according to the Constitution, is that if those rates prevent the company from earning less than a fair return upon the present value of the property used in the service of the public, then those rates are too low and violate the Constitution. It has never decided that rates must be fixed at such a point that only a fair return will be earned, and it is easy to see that there may be other elements entering into the problem. A railroad company experiences years of depression, during which earnings are less than normal. In order to earn a fair return on the average it must, therefore, earn more than a fair return in good years to balance the years in which it will earn less, under any rate schedule; and, furthermore, it must be allowed to earn a surplus, to provide for unforeseen contingencies, such as floods, earthquakes, etc. Rates cannot be suddenly changed, as in the case of an industrial property, to conform to varying conditions. A certain degree of flexibility of rates, giving the opportunity to meet emergencies, now often impossible under our regulating system, is much to be desired, but, in general, rates should be stable. The basis of a fair return upon the present value of the property used in the service of the public seems, therefore, clearly to indicate only the *minimum* return.

The Supreme Court, however, has distinctly said that if the rates charged by a public utility corporation do *not* afford a fair return on the fair present value of the property used in the service of the public, those rates are confiscatory and therefore unconstitutional. It becomes necessary, therefore, in many cases to find such fair present value.

The term value is one of the most uncertain in the dictionary. It may mean very different things. The problem of ascertaining the present value of a complex operating property is consequently necessarily one of those uncertain problems, partly depending upon engineering facts, partly upon economic doctrine, and

partly upon a perception of justice and equity as between the public and the owners, in which almost every question, including the desirability of a valuation at all, is involved in controversy; while upon some fundamental principles the opinions of those who might be deemed equally capable of forming a judgment may differ widely. It is, therefore, not a subject to be dealt with by the young, the immature, or the prejudiced. It is not a proper subject for the college curriculum, except for selected students in graduated courses. It calls for the power of logical, careful reasoning, for experience, for good judgment, and above all for a well balanced mind, fair and impartial, which sees things as they are, has no prejudices, appreciates the wide bearings of the subject, can judge of remote consequences, can disentangle conflicting threads of argument, and can take the broadest and sanest view of the relations of the public to the individual. The problems of valuation are indeed more dependent for a correct solution upon attitude of mind and capacity for logical thought than upon anything else, and next upon experience, that great and only teacher.

Where almost every point involved is the subject of controversy and difference of opinion it is difficult to select any special points for discussion; yet it seems not inappropriate to choose a few of the fundamental principles, and to outline some of the main differences between opposing points of view. I do this the more readily because of the increasing *popular* attention that the subject is attracting, and in the hope that if some of you have not yet thought deeply upon these questions it may suggest some ideas, and indicate to you the many uncertainties of the subject and the necessity for careful consideration of many points of view before arriving at a conclusion. My own personal views are, naturally, strenuously opposed by those who think differently. My only excuse for speaking of this subject lies in its increasing popular importance, and in the fact that circumstances have called upon me, during the past ten years, to make valuations of property aggregating nearly two billion dollars in value, so that, at all events, however I may lack in judgment or sanity I cannot be charged with inexperience.

As a primary basis for ascertaining fair present value the following are available:

1. The cost of the property to date; new, or after deducting depreciation.
2. The cost of reproducing the property at the present time; new, or after deducting depreciation.
3. The market value of its securities.
4. The capitalized earnings.

The basis of the *commercial* value of a public utility, or of any other commercial property, is plainly *earning power*, present or potential. No one would willingly invest in or buy such a property unless he could see the prospect of a fair return. It might be earning nothing, or even losing heavily at the time, but he might not see possibilities of readjustment, improvement, or additional business, or other possibilities which would justify him in paying a considerable sum for the property. Most public utilities are naturally and properly monopolies. It is not in the interests of the public in the end that two railroads should be built in the same territory where one is ample for the business. If two exist, they must to a certain extent, in the public interest, be operated as a combined monopoly. The days of unrestricted competition have passed. But a public utility is a monopoly which derives its power in part from a charter or rights conferred upon it by the public. It must, therefore, be subject to public regulation, and must be operated in such a manner that none of the rights of the public, legal or moral, will be infringed. In a certain limited sense it is the agent of the public which has conferred upon it the right to perform a certain service which the public requires.

The Supreme Court has recognized the above four primary elements in ascertaining fair value, together with other elements not here mentioned. In rate cases present earnings cannot, of course, be considered as a basis, because the object is to fix the rates and the earnings depend upon the rates. Some other basis must here be found. The market value of the securities can be found at any time by an accountant. They may, however, be temporarily and unduly inflated or depressed, so that the market value at any given time may not represent the value of the

property. There remain the other two bases of value, viz.: the original cost and the cost of reproduction; and the first point to which I wish to direct your attention is the great difference of opinion which exists with reference to these two methods of finding value. Each has its ardent advocates. It is claimed on the one hand, in favor of original cost, that this represents the sacrifice which the owners have made to produce the property, and that they are entitled to a fair return upon no more than this sum, or, if the property is taken, to a payment of no more than this sum.

As one college economist expresses it,

On any sound principle there should be no valuation for rate regulation but history, that is, a statement of outlay, of money spent and services rendered, nothing more. . . . As an agent the utility exercises the right of eminent domain, must give an account of its stewardship, is subject to continuous control, is liable for compulsory service, and must coöperate with all other public agents of its principals, the State.

It is held by this writer, and by some others, that the relation between the public and the utility company is strictly the legal relation of principal and agent. Your able California attorney, Mr. Max Thelen, among others, takes this view. The advocates of this view hold that the agent is only entitled to receive his expenses and fair compensation for his services, and that if he makes a profit he "may be held as a trustee and compelled to account to his principal for all profits and advantages acquired by him out of the relationship." This leads them to the conclusion that a public utility should receive a return only "on the money reasonably and properly expended in the acquisition and construction of its works actually and properly in use to carry out its agency, no more and no less." If lands were donated by the State to the company to enable it to construct its works, the company is not to be allowed to earn any return upon those lands when they have become valuable, or if it acquires lands at a low cost it is only to be allowed a return upon such actual cost.

On the other hand, this view is rejected by most students of the subject. It seems far-fetched and fanciful to most people, and it has never had the sanction of the highest courts. Those who oppose it urge that while a public utility may be termed in a limited sense the agent of the public, it is in no sense a legal

agent. The conclusions above stated clearly do not follow when the principal has allowed that agent to manage the property for years without supervision or restriction and perhaps at a loss, and without a definite understanding at the beginning as to the legal relation between the parties, has allowed it to charge what rates it pleased, subject to competition, to earn what profits it could, to go through bankruptcy, perhaps several times, without interference by the principal. They urge that rights were given to the company by its charter because those rights were necessary to enable the works to be constructed, for without the power of taking land by eminent domain it would probably be practically impossible to construct a railroad. They urge that public lands were given originally in some cases because without giving them the public could not induce the company to build the works, and that once given they are the property of the company, like any other private property; they maintain that the public desired the works to be built because it saw that they were essential for the prosperity of the State, but that the risk of loss was left entirely with the company, and, therefore, that it should have the ownership of its property and the possibility of profits when they become possible. They say that lands originally given to the company by the state were given absolutely, without condition or agreement, that they were intended to be, and have always been considered to be the absolute property of the company, that they were given, as a matter of fact, in consideration of advantages which the public expected to receive in compensation and which the public has actually received manifold in compensation. They say that if the company was merely the legal agent of the public that relationship should have been established and understood by both parties at the beginning, which has never been the case. They say that if the legal relation of principal and agent is to hold, the agent must be subject to the continual supervision of the principal, and that after allowing a railroad company to manage its own affairs for decades, to go through foreclosures and receiverships without any guarantee of protection against loss on the part of the principal, it is inequitable and illegal for the principal at a later time to step in, claiming that the legal relation of principal and agent is to be assumed and that the company, after it has become prosperous,

is then to be allowed to earn no more than a fair return upon the original cost.

Moreover, the highest courts have stated, again and again, that while it is at least the present value of the property which the company employs for the public convenience which is entitled to a fair return in rates, or to be paid as compensation in a taking, this fair value is *not the original cost* thereof. For instance, in *San Diego Land and Town Co. vs. Jasper*, 189 U. S. 442, the court said:

The main object of attack is the valuation of the plant. It no longer is open to dispute that under the Constitution what the company is entitled to demand in order that it may have just compensation is a fair return upon the reasonable value of the property at the time it is being used for the public.—*San Diego Land and Town Co. vs. National City*, 174 U. S. 793-757.

That is decided and is decided as against the contention that you ought to take actual cost of the plant, annual depreciation, etc., and to allow a fair profit on that footing, over and above expenses.

Again, in the *Minnesota Rate Cases*, 230 U. S. 454, the court said:

It is clear that in ascertaining the present value we are not limited to the consideration of the amount of the actual investment. If that has been reckless or improvident losses may be sustained which the community does not underwrite. As the company may not be protected in its actual investment, if the value of its property be plainly less, so the making of a just return for the use of the property involves recognition of its fair value if it be more than its cost. The property is *held in private ownership* and it is that property and *not the original cost of it* of which the owner may not be deprived without due process of law. [*Italics mine. G. F. S.*]

The advocates of the original cost theory are always careful to remark that the first cost is not to be taken if the company has been wasteful or extravagant, that is, if the value is less than that cost; but they strenuously oppose making any additions to that first cost if the investment has been skillfully made and has resulted in an increased value to the property.

As a matter of fact, the first cost theory does place a premium upon and encourage wasteful, extravagant, and inefficient construction. Every engineer knows that there is a wide range within which the cost of construction may be reasonable. In a case in which the speaker was recently consulted there were four bids for constructing a certain property, all by responsible and skilled contractors. The highest three bids were close together, although there was no evidence of collusion, and were double the

lowest bid. The latter proved to be too low, and the contractor lost money; his actual cost being about two-thirds that of the highest-bidder. Even the highest bid could not have been considered an unreasonable one.

When a railroad is constructed it is given certain rights by the public, but those rights are only those which are necessary in order to secure the construction. A railroad is given the right of eminent domain because without that right it would be impracticable to build the road. So of the right given to a street railway company to lay its tracks in the streets, or to a gas company to lay its mains in the streets. The public grants the rights because it wants the commodity which the utility is to furnish. Not infrequently it is more anxious to grant the charter than the company is to receive it. It leaves the company unrestricted for many years in the conduct of its business and in its financial management, and finally comes in to regulate it and to fix its value. In the meantime the community has grown, lands which perhaps were donated to the company have increased in value in common with all other lands in the neighborhood, largely due to the presence of the utility, and now it is said by the advocates of original cost that since those lands were donated to the company it is not to be allowed to earn any return upon the value of those lands, because the public should not be required to pay any rates for what it has itself given. In the meantime the property may have changed hands a dozen times at prices determined by the competitive theory, that is to say, based upon the earnings which the public has allowed the company to make without restriction. The original company may have been succeeded several times by new companies. Nevertheless, they claim it is now to be allowed to earn a return only upon the original cost, notwithstanding the decisions of the courts that costs is not value.

The decisions of the courts are no stumbling block in the way of some of those who advocate this theory, and one of them, a college economist, sweeps the difficulties away by saying that the present uncertainties and unsatisfactory condition are due to these decisions of the Supreme Court and that they will continue until that Court is compelled by public opinion to reverse itself or until its power is changed by constitutional amendment. This

illustrates the character of much of the discussion on this question. The author referred to evidently considers that he and he alone, and those who agree with him, are infallible, that anybody who disagrees with him is wrong, including the Supreme Court of the United States, which must be compelled to reverse itself.

In connection with the original cost theory it is also asked by some, in case its value is to be ascertained on the basis of first cost, just what is meant? The first cost to whom? To the owners, or to previous owners? If your property is to be taken from you on the basis of its original cost, should that be its cost to you or to somebody else? It is urged, for instance, that certain individuals might get together, obtain a franchise, and build a railroad. They may be shrewd and far-sighted, may locate the road with exceptional skill, and may build it under exceptionally favorable conditions when prices are very low, or perhaps when they can get certain of the work done at prices which can never be again obtained. For instance, they may be able to get a good deal of their grading or filling done for nothing, or they may even be paid for it, for somebody else at the moment may have a large quantity of earth, taken perhaps from a subway or tunnel in a city, which he wants to dispose of, and unless he can dispose of it to the utility he will have to pay a large sum to carry it elsewhere. He may, therefore, be willing to dispose of it to the utility and to place it for next to nothing or even to make a payment therefore. At all events, the road may be supposed to be constructed at an extremely low cost. It fills a need and develops a good business, and a few years afterward some new parties appear and seeing that it was built most economically and has great possibilities, they may buy it from the original builders at a large advance over what the latter paid for it, and yet perhaps less than it would cost them at the time to reproduce it, or to build another road. They buy it at that price. Years go by and the property becomes subject to public regulation, and is now to be taken for public purposes, or its rates fixed. Is it equitable to pay the new owners what they paid for it or what their predecessors paid for it?

Of course the answer which is made to this suggestion by those who hold the theory of principal and agent is that the agent of the public is the company and not the individuals who happen to

own it and hence individual ownership is of no consequence. But how is this when not simply the stockholders have changed, but when the original corporation has been succeeded by a new one? Is the new corporation the agent, or not? If it is, then the cost to it should be taken; if it is not, the whole theory falls.

The case, however, is certainly not so simple as some would make it appear, nor can it be decided offhand by simply asserting that the Supreme Court is all wrong. Certain it is that the theory of principal and agent, and the use of first cost, if applied as some have urged that it should be applied would very likely wipe out millions of dollars of investment honestly made and even sanctioned by regulating commissions.

Moreover, the theory of first cost, it is claimed, leaves entirely out of account the element of competition, which still remains to a certain extent, though under regulation. There may be two railroad lines between the same two cities, and extending no farther. One of them necessarily has the best location and originally cost much less than the other. If the rates are to be based upon original cost the more cheaply built road will obtain all the business, and the building of new roads will be absolutely prevented. This argument, of course, applies equally to the cost of reproduction theory, and indicates that as a basis for rates neither result is at all conclusive. Would this not be true equally in case of a taking? If the public should take the more economically built road at its original cost it would thereby become possessed of an asset with which it could wage war against the later and more expensive road, to the extermination of the latter, although it had chartered it and was equally its principal. It is asked whether the state should use its paramount powers to ruin agencies that it has itself authorized. To many it is clear that no valuation has much, if any, relation to rates, which should be determined by what the traffic will bear.

By some it is considered that public ownership is the only solution of these problems, but the experience with public ownership is decidedly against its advantage to the public, and especially in a democracy it would be a distinct public menace.

Another consideration is urged with reference to the original cost theory. If the basis of this theory is that it is the sacrifice made by the agent which is the basis of value, it must be his

total sacrifice, and if in any years of the enterprise he did not receive a fair return on his investment any deficiency below a fair return must be added to that investment and compounded from year to year. Additions of this kind may easily result in a great increase above the original cost investment. Moreover, it is not only the cost of the property that is to be taken but also the cost of developing the business to its present condition, including all expenditures, direct or indirect.

Your able California attorney, Mr. Thelen, appears to hold this view, for he quotes with approval from a decision by another eminent Californian, Secretary Lane, who in the Western Advance Rate Case said:

Perhaps the nearest approximation to a fair standard is that of bona fide investment, the sacrifice made by the owners of the property, considering as part of the investment any shortage of return that there may be in the early years of the enterprise. Upon this, taking the life history of the road through a number of years, its promoters are entitled to a reasonable return. This, however, manifestly is limited, for a return should not be given upon wastefulness, mismanagement, or poor judgment, and always there is present the restriction that no more than a reasonable rate shall be charged.

Those who oppose the original cost method fail, however, to see why Mr. Lane should limit the shortage of return to the early years of the enterprise, or why every shortage from the beginning to the time of decision should not be allowed. They maintain also that if from the original cost is to be deducted any losses due to "wastefulness, mismanagement, or poor judgment," then there should also be allowed any profits accruing from economy, efficient management, and good judgment; and admitting that there is always present the restrictions that no more than a reasonable rate shall be charged, which Mr. Lane implies is a restriction independent of first cost, they claim that this means also that no less than a reasonable rate shall be charged, that is, a reasonable recompense for the service rendered, also entirely independent of first cost.

Against this view that deficiencies of earnings should be included in original cost, it is urged by some that the mere physical property would be worth nothing aside from its operation, that the construction of the property means constructing a property that has, or is capable of having, business, but which without

the business is valueless. Giving the physical bare bones a value is only justified, they say, if it has the business too. They refuse, therefore, to allow any deficiency of earnings. In taking this ground they clearly abandon the position that the sacrifice of the owners is the fair value of the property. As for the capitalization of a deficiency in earnings it is also urged by a few that this would amount to a guarantee by the public of a fair return, which they say the public can never make even though it is a principal. This view, however, clearly involves a fallacy in regard to the meaning of the word guarantee. To allow a capitalization of a deficiency of earnings is not to guarantee a fair return. The public, of course, should never guarantee a public service corporation, which it charters, against being a *losing venture*; but ought it not to guarantee to it rates which, if those rates will produce the traffic, that is, if the traffic will bear those rates, will *prevent* it from being a losing venture? As the price of any commodity, including transportation, is raised, the demand for it generally decreases. At some point the price will result in a demand which will produce the maximum return. That maximum return may not be enough to constitute a fair return on the investment. In this case the concern is a losing venture, and the public cannot guarantee it, and ought not to guarantee it against such contingency. But, on the other hand, if the public is to regulate rates and values, ought it not to guarantee a rate high enough to produce a fair return even on a value which includes deficiency of earnings in previous years, if such a result is possible? If this view is not taken no one will invest in a public utility. If you invest in a public utility you take some risk. You are willing to take the risk because your judgment tells you that the concern will be a success, but would you make the investment if you knew that the public was to come in later and prevent your receiving even a fair return on your investment from the beginning though it might become capable of producing large returns? These illustrations are not fanciful. Street railways in many parts of the country are in a condition which justifies them. In Massachusetts they have become so seriously crippled that the public is not obtaining anything like the service that it ought to have. The shares of one corporation, in whose capitalization there is admittedly not a dollar of water,

which has been under public regulation from the beginning and some of whose stock has been issued at a price of \$155 a share, as fixed by the state regulating body at the time, has been recently selling for under \$30.

The theory of cost of reproduction as a basis of value has also its defects and opponents. Those who oppose it are particularly active and caustic in their criticism. They designate it by all sorts of epithets. One eminent critic of this theory and advocate of the original cost theory says that the reproduction cost theory is "utterly dishonest." This critic knows perfectly well that the Supreme Court in at least two decisions has spoken favorably of this theory. In the Knoxville case the Court said:

The cost of reproduction is *one way* of ascertaining the present value of a plant like that of a public utility company, but that test would lead to obviously incorrect results if the cost of reproduction is not diminished by the depreciation which has come from age and use.

In the Minnesota rate case the Court said:

The cost of reproduction method is of service in ascertaining the present value of the plant when it is reasonably applied, and when the cost of reproducing the property may be ascertained with a proper degree of certainty, but it does not justify the acceptance of results which depend upon mere conjecture.

Moreover, the same court in a later case, that of the Des Moines Gas Co. (238 U. S. 153), distinctly upheld the cost of reproduction method, saying, in approval of what had been done:

After valuing the real estate and various items of personal property, as hereinafter stated, the master adopted as the only practical way, in his judgment, of determining the reasonable value of the buildings, their contents, yard structures, and the mains, house and street lamp service, and meters, the test of estimating the cost of reproducing them new and then estimating the depreciation which should be deducted in order to obtain their present value.

Notwithstanding these decisions of our highest court this critic says the theory is "utterly dishonest."

Those who oppose the cost of reproduction method sometimes intimate that it is only used by those who desire to arrive at a high valuation. Thus, the same critic said, in an official decision, "The reproduction cost theory has during recent years become a *fashionable* one among many attorneys and managers of *public service corporations*." He perhaps forgets that in the leading case of *Smyth vs. Ames*, counsel for the railroad maintained that

the original investment should be the basis. It appears that, when the roads were built, wages were above normal, prices high, and gold at a heavy premium, and that when the action was brought prices had materially declined, so that it was estimated that the roads could then be reproduced for less than the original cost. On the other hand, counsel for the state then maintained that "the present value, as measured by the cost of reproduction" was the proper basis. Hence the critic might equally well have said that the original cost theory had during recent years become a fashionable one among many attorneys for and members of public commissions. The value of the theory is to be judged not by the persons who hold it, but by its own merits and the decisions of the highest courts, which we should always respect though we may personally disagree with them.

Those who uphold the cost of reproduction theory, so far as I have read their views, appear to be more reasonable and moderate in their expressions. They respect the opinions of the Supreme Court and neither term them utterly dishonest nor say that the Court must be forced to reverse itself. Most of them appear to believe, as the Supreme Court does, that neither reproduction cost nor original cost is alone the criterion, though they believe that cost of reproduction, properly ascertained, is much nearer to fair present value than original cost, while some of the writers who support the original cost theory apparently maintain that it and they alone are infallible. The advocates of the reproduction cost theory urge, certainly not without reason, that if, as the Supreme Court has said, it is the fair present value of the property which is to be the basis, then let us suppose the following case:

Suppose a railroad passes through a town. It has its right of way, its bridges, its embankments. The problem is to find the present value. Suppose it should build a branch from its station in that town, diverting from its main line. It would have to buy property, build bridges and embankments. On the original cost theory, which no doubt here applies, the cost of its right of way would be its value. They ask then, is the present value of the right of way of the main line, only one hundred feet away, built fifty years ago, which goes through precisely similar property, any *less* than the value of the branch right of way just built

simply because it was built earlier? Extend the illustration. Suppose that the railroad company needs to enlarge its yard and must widen its right of way or take a block adjoining one which it already possesses. It takes that property, enlarges its yard, builds its embankments and bridges if necessary. The cost of that new property is its value at the time. Is the value of the other block previously existing any less? It is in exactly the same locality and under similar conditions. Why, they say, should there be a difference in the present value?

Those who advocate the original cost method are seriously disturbed by the fear that the use of the cost of reproduction method will lead to rapidly increasing values and rates. Thus Commissioner Lane, in the Western Advance Rate case, referring to the contention of the Burlington Road that it was entitled to a return on unearned increment in land value, said:

If this is a precise expression of what our courts will hold to be the law, then, as we are told, there is certainly the danger that we may never expect railroad rates to be lower than they are at present. On the contrary there is the unwelcome promise made in this case that they will continuously advance.

and he adds:

In the face of such an economic philosophy, if stable and equitable rates are to be maintained the suggestion has been made that it would be wise for the Government to protect its people by taking to itself these properties at present value rather than to await the day, perhaps twenty or thirty years hence when they will have multiplied in value ten or twenty fold.

In the case of Buffalo Gas Co. vs. City of Buffalo (N. Y. Public Service Commission, 2nd District, Vol. 3, 633), the Commission said:

A valuation made in the case of this company in 1907 would produce vastly different results from a valuation made in 1912, owing to the different prices of pipe, and yet there can scarcely be any disagreement upon the proposition that the price of gas in 1907 and 1912 should be substantially the same. A condition of things which permits the *public* to appeal to this Commission to fix the rate in times of financial distress when materials are low and labor is cheap and thereby obtain a low rate which shall obtain permanently or substantially so; and on the other hand which permits the company to appeal to the Commission to fix a rate at a time when labor is high and materials are dear, and thereby fix a higher rate to continue with a substantial permanency, is intolerable. If the Commission were to fix the price of iron pipe upon the prices now prevailing, next year they may be 50 degrees higher. Justice would require that the rate go up if the cost of reproduction now is to prevail; while, on the other hand, if pipe gets lower the rates should be lower. This would require a constant juggling with prices in order to carry out what would be deemed substantial justice.

To these criticisms of the method the following reply may be made.

In the first place, Secretary Lane's suggestion, that railroad values may be multiplied ten or twentyfold, is an exaggeration. His fear seems to have reference mainly to the increase of land values, since values of the other elements may be expected to fluctuate up and down, generally speaking; but the value of land in a railroad valuation is, on the average, only from about 15 per cent to 25 per cent of the total value, so that if land values should be multiplied ten times, which is very excessive, with other values unchanged on the average the total value of the property would be increased only about three times instead of "ten or twentyfold."

Secretary Lane seems to think that railroad rates should be expected to be lower in future than at present, and the New York Public Service Commission seem to think that the price of gas should remain substantially the same. The price of money, of labor, of every material thing, varies from year to year, and it may be pertinent to ask why it should be assumed that the price of transportation or of gas should remain the same or should fall. It is, of course, desirable that rates should remain stable, and, if public service companies are allowed to earn a fair surplus to provide for fluctuations from year to year, they will remain fairly stable, as compared with the prices of materials or money. The price of a thing changes either because of conditions affecting it, which change its value, including among these supply and demand, or because of a general change in the value of a dollar. If, by reason of an excess of currency, the value of the dollar decreases, that is to say, if it takes more dollars to buy a given thing, why should transportation or gas, which are commodities, be exempt from the general change in price?

Further, with reference to Secretary Lane's suggestion, it is very doubtful in the minds of a great many people if protecting the people means limiting the taxes and other charges imposed upon them, whether the taking possession of the properties by the government will protect the people. The experience with government ownership does not show that it leads to decreased charges, although it may be possible to hide those charges in the general tax levy so that the average man may lose sight of them.

Certainly many intelligent and unprejudiced men believe that a great disillusioning will come upon the American people if they resort to government ownership in the hope of reducing charges.

Further, with reference to the statement of the New York Public Service Commission, it may be said that those who believe in the cost of reproduction method do not as a rule look upon a valuation as a thing to be made from year to year or whenever demanded by the public or the corporation. With the increase of public control, assuming the desirability of ascertaining the physical value of public utility properties or the necessity of doing so in some cases, these people maintain that such values should be ascertained once for all simply as a starting point. They believe that the past should be wiped out, and a new start made, that any past errors on the part of the companies in the way of financial mismanagement or overcapitalization, and any mistakes on the part of the public in allowing such things to happen, or in allowing rates which are too high, or rates which were so low as to result in financial embarrassment or bankruptcy, should equally be forgotten, but that a new start should now be made with a valuation of the physical property at the present time, and that hereafter such methods of accounting and such rules controlling the issue of securities and the application of the proceeds should be adopted as will insure that the value of the physical property at a future time can be ascertained on the basis of the present value and the operating results since it was made. This was even the view of Director Prouty, who, as a member of the Interstate Commerce Commission, in an address before the National Association of Manufacturers in New York in 1907 said:

The popular impression that if the value of our railroads were known it would be easy for us to adjust rates that a fair return upon that value and only a fair return would be obtained, is entirely erroneous. The most that can be done in most cases in fixing the value of our railroads would be to determine the cost of their reproduction at the present time. . . . Such a valuation would . . . establish, as it were, a point of departure today from which future values might in some measure be reckoned.

Commissioner Prouty evidently at that time believed that the only thing that could be done in the case of railroads was to use the cost of reproduction method, and he further evidently believed

that once applied it would be not necessary to use it again, but that it would serve as a point of departure for the future. This, I think, is the view taken by most advocates of the cost of reproduction method.

These considerations may perhaps indicate to you the complicated character of the problem and especially the mental characteristics of some of the individuals who deal with it. They will perhaps substantiate the statement made at the beginning of this lecture that the attitude of mind with which a subject of this kind is approached is perhaps the most important element in arriving at a correct conclusion.

As illustrating the lengths to which some advocates of the original cost theory go, one of them maintains that overhead expenses for engineering, if paid out of operating expenses after the plant is put into use by members of the regular staff, are not to be considered even in original cost. In other words, if a company builds a temporary bridge at the beginning, puts its road into operation, and subsequently replaces this bridge by an expensive steel structure designed by its regular staff of engineers, the engineering expense connected with this bridge is not to be considered as original cost because done by the regular salaried staff. In other words, this writer apparently believes that not even actual original cost is to be used.

But, after all, much of this discussion is purely academic in view of the fact that in many cases, as, for instance, in the case of a railroad of considerable age, it is generally impossible to ascertain the original cost. So far as I know, no complete estimate of the original cost of any large railroad has yet been found, or the deficiency in earnings in lean years worked out. All valuations of such roads have been based on estimating the cost of reproduction. This can be done with comparative ease, as it involves simply making an inventory of the property and placing upon each item the cost of producing it at the present time. The original cost cannot be found because, in the first place, the records are in many cases destroyed or inaccessible, and, in the second place, because in the past accounts have not been kept in such a way as to distinguish between amounts properly chargeable to replacements and amounts properly chargeable to new

construction. When our railroads were built they were, as a rule, constructed cheaply, because the money was not available to construct them in any other way. As traffic grew and revenue increased, a wooden trestle, for instance, would be replaced by a steel bridge. The entire cost of the replacement would be charged to operating expenses. The banks of a cut, originally with a certain slope, would slide through the action of water, and additional material would have to be taken out to make the slope of the banks less. This would be charged to operating expenses. As a matter of fact, the latter expense is properly chargeable to the original cost of producing the cut in its later condition, as the excess cost of the steel bridge over the cost of replacing the wooden trestle is also properly chargeable to original cost. It is probably impossible to disentangle these accounts at the present time in such a way as to ascertain the original cost of a large railroad.

It may be urged that the accounts should have been kept in such a manner as to capitalize all expenses above those necessary to renew worn-out parts in the way in which they were originally built. On the other hand, there is something to be said in favor of the method of accounting which has been followed in this country. If all renewals beyond replacements in kind are charged to capital, a steady increase in capitalization and rates necessarily results. In this manner the large capital of some of the foreign roads has been produced. Our railroads, on the contrary, have preferred to keep their capital low by taking advantage of good years to make extensive replacements and improvements, charging them to operating expenses. It is urged, on the one hand, that since the revenue with which to pay for this replacement came from operating expenses and these revenues were contributed by the public in the form of rates, the public has contributed to the company a portion of its capital, and, therefore, that the company is not entitled at the present time to any return to it by the public in rates upon such capital; but it should be remembered that the public had it in its power to regulate rates and to prevent such return of capital to a considerable extent, and that it did not do so. Further, the surplus might have been distributed to stockholders. The result of this development has been that this country has become possessed of

a system of railroads unequalled by those in any other country in the service that they give, and capitalized at a figure lower than in any other country, and carrying their traffic at rates lower, on the whole, than any other country. The history of the past, therefore, has not been entirely unfavorable to the interests of the public. With more stringent regulation, the history of the future, many believe, will not be so favorable.

As a result of considering the controversy between the original cost method and the cost of reproduction method many disinterested students have finally come to the same conclusion, which is this: Neither method of ascertaining value is in all cases, or perhaps in any case, the exclusive basis. Both should be considered, if ascertainable. The wisdom of the decision of the Supreme Court in the case of *Smythe vs. Ames*, so many times quoted, will, I think, become more apparent the more carefully this question is studied. It reads as follows:

We hold, however, that the basis of all calculations as to the reasonableness of rates to be charged by a corporation maintaining a highway under legislative sanction must be the fair value of the property being used by it for the convenience of the public. And in order to ascertain that value the original cost of construction, the amount expended in permanent improvements, the amount and market value of its bonds and stocks, the present as compared with the original cost of construction, the probable earning capacity of the property under particular rates prescribed by statute, and the sum required to meet operating expenses, are all matters for consideration and are to be given weight as may be just and right in each case. We do not say that there may not be other matters to be regarded in estimating the value of the property. What the company is entitled to ask is a fair return upon the value of that which it employs for the public convenience.

Furthermore, many will thoroughly approve the words of your own eminent jurist, Justice H. M. Wright, who makes the following remarks with reference to the original cost method:

Original cost is urged as a criterion of value by certain economists and state officials. The theory is that the return in money which is the inducement and the reward for serving the community with water or gas, or other service, is justly to be determined on the basis of the amount of sacrifice on the part of the investor, and this amount of sacrifice is summarily identified with the original investment in existing property. The assumption neglects to take account of the fact that there would ordinarily be successive owners of the property or of shares in it, and at different purchase prices. Furthermore, the test proposed applies to property devoted to the public use, the socialistic basis for fixing value, while the property of all other persons in the community is valued in accordance with the non-socialistic basis of our economic structure with-

out reference to its cost. Money, the measure of value, changes in purchasing power in obedience to economic laws. . . . Original cost is of course a test of controlling importance in the case of newly constructed or acquired property. It may be a valuable check upon the value of property of moderate age; but generally it will have no significance as regards property, say of forty or fifty years' elapsed life.

I think that most unprejudiced students after considering these matters, will be apt to agree with Judge Wright and to reach substantially the following conclusions:

In the case of a public utility constructed today and under public regulation from the beginning, the investor should be satisfied with a fair return, commensurate with the risk involved, upon the actual investment. If rates sufficiently high to produce such return are guaranteed by the public the investor must take the risk that the investment will be a losing proposition, and that when rates are fixed so as to produce a maximum return that maximum may be less than a fair return upon the investment. What a fair return is will depend upon this risk, but he should be guaranteed that the public will not interfere with the imposition of rates which, if they can be collected, will produce such fair return.

In the case of utilities of comparatively recent construction, and especially if under public regulation from the beginning, the same basis would hold. In the case, however, of utilities which have been allowed to operate for many years without public regulation, a new start should now be made and a valuation fixed as a starting point, accounting methods and the issue of securities to be subject to public approval in the future. The value to be fixed as a new starting point should be, as the courts have decided, *not less* than the fair present value of the properties and in the ascertainment of such fair present value, as Judge Wright so wisely says, the original cost will have no significance. Indeed, neither original cost nor reproduction cost will be the sole test, but we shall come back to the words of wisdom, so often quoted, in the case of *Smythe vs. Ames*.

Another of the much discussed points regarding valuation may now be referred to, as it is of great importance, namely, the question whether depreciation should be deducted from the value now, whether found by the original cost method or the cost of reproduction method.

When an industrial plant or a public service plant is put into operation, many of the individual units immediately begin to depreciate in value and condition on account of use, wear, decay, and perhaps approaching obsolescence. The time will come when such units will have to be replaced. How shall this be provided for? At first sight it appears that the proper method would be to set aside each year out of earnings, the total amount of the accrued depreciation in that year, and to carry the sums so set aside in a depreciation or reserve fund, paying out of this fund each year for the renewals in kind which are necessary. This places the company in strong financial position and enables it to meet renewals when due. Such a fund, however, is a return of capital to the company by those who buy its product. The same result might be accomplished by building up a surplus, but in this case stockholders might demand a distribution of this surplus, whereas if the proper amount is held in a depreciation fund stockholders may not demand that this be distributed.

Such a procedure is eminently desirable, and generally possible, in the case of an industrial plant, for just two reasons: (1) that the industrial concern can charge any price that it pleases for its product; (2) that an industrial plant frequently finds itself in a position in which it is necessary to make very extensive renewals in a single year. Let us consider these reasons.

1. An industrial plant is not subject, except perhaps in exceptional times like the present, to any public regulation. It can charge what it likes for its product. It is limited only by competition with other concerns making similar products, and it generally and properly aims to make the prices which it charges such as will produce a volume of sales that will result in the maximum net return. Whether it makes rails or razors, or drugs, or soap, or furniture, or refined oil, or any other industrial product, it is not limited by the public in regard to the prices which it can exact. It may earn 40, 50, or even 100 per cent of its capital stock in a single year.

2. An industrial plant frequently finds it necessary to make large renewals in a single year. Improvements in machinery and methods of manufacture, the introduction of new apparatus and processes, and other circumstances, some of them unforeseen and unforeseeable, may at some time render it necessary to entirely

reconstruct the plant in order to enable it to do business economically and to meet competition. When such expenditures become necessary, if the company has not accumulated a surplus or a depreciation fund sufficient for the purpose it may find itself in a serious situation. It will either be obliged to continue its business without making the renewals which are necessary and which will result in economy, or it must get new capital for the purpose. It is, therefore, wise for it to accumulate a depreciation fund. It should make hay while the sun shines, and while it enjoys a good business it should provide for the inevitable future.

Now when such a depreciation fund has been accumulated, what is it? Clearly it is original capital which has been returned to the company by those who have bought its products in past years. It is amortization of the capital. The balance sheet shows this clearly. On the asset side stands the original cost. From this is deducted the depreciation, so that the cost is carried at a depreciated value. On the same side stands the depreciation fund, which should be equal to the deducted depreciation. On the liability side stands the original capital. When any renewal of a part of the plant is necessary the situation is this: the original investment in that part of the plant has not only earned for its owners a fair return during its life, but the original capital investment in it has also been returned to the owners by the public, and is now available by the company for a renewal of that element.

A public service corporation, and particularly a railroad, differs radically from an industrial plant in regard to both of the elements which justify the accumulation of a depreciation fund.

In the first place a railroad company is not justified in asking the public to return to it any portion of its original capital. It is under public regulation. Its rates are subject to being fixed by a public commission, and if they were not, public opinion would exert a corresponding pressure. If the public, through its regulating body, requires or allows the company to accumulate a depreciation fund, and permits it to charge rates sufficient for the purpose, it may be wise in certain particular cases for the company to set aside such a fund. In electric light plants, gas plants, to some extent in water works, where, as in industrial

corporations, large renewals may become necessary in a single year, it may be desirable to accumulate such a fund, and in some instances the public authorities permit it, and perhaps require it.

A railroad, however, is essentially different. It will never need renewal as a whole, or in any large part, because it consists of such an immense number of separate units. It will presently be shown, also, that in the case of a railroad the accumulation of such a fund is neither necessary nor desirable.

What should a railroad company be allowed to obtain from the public in return for the commodity which it furnishes? (1) It should be enabled to earn its operating expenses, because it has to pay them out year by year, or perhaps week by week. (2) It should be allowed to earn its taxes, which are paid to the public. (3) It should be allowed to earn its fixed charges or the interest on its fixed capital obligations, because if it does not it may be obliged to go into the hands of a receiver, or to borrow money to pay interest, which would be bad financial policy, and could only be done at high rates if at all. (4) It must be allowed to earn enough to pay for renewals as they become necessary. Otherwise the property will run down and become less efficient as a servant of the public. (5) It should be allowed to earn a fair return to its owners on the capital stock. These then, are the earnings which a railroad should be allowed to make: operating expenses, taxes, fixed charges, maintenance and necessary renewals, a fair return. Should it also be allowed or required to earn the amount of accrued depreciation and to carry this in a depreciation fund?

A little consideration will show that this is neither necessary nor desirable, for the reason that a railroad lacks the second element which makes the accumulation of such a fund desirable in the case of an industrial corporation. No large part or element of a railroad will require renewal in any one year, because the multiplicity of its parts is so great. Annually accruing depreciation and annual expenses for renewals tend to reach a condition of equilibrium in which one of these is equal to the other. By skillful management the departure from this condition of equilibrium may be made very small. If a large bridge is weak and needs renewal there are various methods of meeting the emergency. The bridge may be strengthened, or temporarily sup-

ported by placing pile bents beneath it and shortening the span. Many bridges needing renewal have been treated in this way, and carried for ten or fifteen years without renewal. If a large structure requires renewal this year the renewal of a corresponding number of smaller structures may be postponed.

To earn anything more than operating expenses, taxes, fixed charges, necessary maintenance and renewals, and a fair return means that the public is returning to the company its capital. The company should by skilled management endeavor to make renewals come due in such a way that they may be fairly uniform from year to year. If in any one year a large item of expense is to be met for renewals other items can be cut down or postponed by temporary measures until subsequent years. If such renewals cannot be met from current earnings the company may borrow money or incur a floating debt for the purpose, which is retired as soon as possible even if rates have to be temporarily somewhat increased in order to do so. Such a plan provides for obsolescence. A new structure may be much better than the one which it replaces but it seems proper that future customers should bear the expense involved in securing the better facilities rather than to have the expense borne by the customers who had only enjoyed the benefit of the inferior facilities previously available. Such a plan puts the burden of paying upon those who enjoy the facilities which they pay for.

Furthermore, it is easy to see that in the case of a railroad, with its great number and diversity of units, to build up a depreciation fund would not only be undesirable but would result in a useless fund. This is true in the case of any concern, whether an industrial concern or a public service corporation, in which the multiplicity of units is such that renewals in time come to be an approximately constant expense.

The situation is best illustrated in the case of the ties of a railroad, because they are the shortest-lived element, and the illustration is easier to grasp. Suppose that a railroad is 10,000 miles long, with 25,000 ties to the mile. It has 25,000,000 ties. If these cost 60 cents apiece they are represented in the capital account by \$15,000,000. If the average length of life of a tie is ten years, then, inasmuch as ties differ and are not all of the same quality when put into the railroad and inasmuch as the wear

upon them differs according to the location and the traffic, they will, even if all are put in at the same time, wear out at different times. Some of them may last only five years, others may last twelve or fifteen, depending upon circumstances. Ultimately, when the condition of equilibrium is reached, there would be an annually accruing depreciation of ties of one-tenth of the capital represented, or \$1,500,000; and during each year about one-tenth of all the ties will be renewed, at a cost of \$1,500,000. The condition of equilibrium is reached when the depreciation of the ties is between 40 and 50 per cent and the depreciated value between 50 and 60 per cent. If a considerable portion of the railroad is new the condition of equilibrium will not have been reached. Tie renewals will not equal annually accruing depreciation. Assume the depreciation to be 40 per cent and the depreciated value 60 per cent. In this case the depreciation in the ties will be 40 per cent of \$15,000,000 or \$6,000,000, and this will be included in the total depreciation of the property. During the following year the annual accruing depreciation would be \$1,500,000, and the tie renewals somewhat less, so that the fund, if it had been set aside, would be increased this year. The condition of equilibrium will be reached when the fund reaches 45 per cent of \$15,000,000, or \$6,750,000. After that time in any one year what is paid into the fund would be exactly balanced by what is taken out of it. The fund would represent capital for ties which has been returned to the company by the public. Of what use is it to accumulate this fund for the simple purpose of having it? If the answer is made, let the fund now be used to meet cost of renewals without adding to the fund out of earnings, then, if this is done, the fund will gradually disappear. But what would be the justification for such a procedure?

At this point another consideration comes in. In an industrial plant the concern not infrequently starts in with large earnings. If it is economically constructed and supplies a commodity that the public wants, the entire field is at once immediately opened to it. Earnings may be large from the beginning. A railroad company is radically different. It is generally built into new country, and in advance of a market for its product, namely, transportation. It builds its line into territory where the transportation facilities have been insufficient, and where the business

must be developed. At the beginning, therefore, its earnings may be small, until the country becomes settled and its resources developed. This is particularly the case with our trans-continental roads, like the Canadian Pacific, Canadian Northern, and the American roads. In early years the earnings may be so small as to produce for a long time no return to stockholders, who must have faith and wait for the development of the country before they get any dividend. In some instances the early returns may be so small that that company cannot pay its fixed charges, and is obliged to reorganize according to a plan which will cut down those fixed charges. Such has been the experience of many American railroads, as is well known. Now what would be the use of requiring a company under such circumstances, in the early days, to set aside a fund to provide for depreciation of ties, thereby burdening it still further. Is it not much better to allow it to develop its traffic as fast as it can, meeting necessary tie renewals as they become necessary from year to year, seeing that ultimately a condition of equilibrium will be reached, without any fund, in which accruing depreciation will be equal to annual expenses for renewals?

Every other element of a railroad is in essentially the same condition that has been described with reference to ties. Bridges wear out, but not all at once, as there are great numbers of them. The same is true of rails, buildings, water tanks, and every other element of property which depreciates.

The above seems clearly to show that the accumulation of a depreciation reserve in the case of a railroad is neither necessary nor desirable. As a matter of fact it is not required in the United States, except in the case of equipment, and this has only been required within a very few years. The Interstate Commerce Commission in all the years of its existence, from 1887, did not require the accumulation of a depreciation reserve, until a few years ago for equipment, and many railroad men believe that even this was unnecessary, because even equipment does not wear out all at once. Furthermore, it may be claimed that with reference to other items than equipment public authorities in America do not permit an accumulation of a depreciation fund for the reason that although it is not prohibited, the public authorities have not in general allowed rates to be high enough to permit of

such a fund being accumulated. No American railroad accumulates a depreciation fund, so far as I am aware, for anything except equipment.

If the public authorities permit or require a depreciation fund to be accumulated, and it is so accumulated and, therefore, represented in the assets and in the physical valuation, then it is proper to deduct depreciation from the value of the property new, the amount so deducted depending upon the accounting regulations with reference to the accumulation of the fund. Here is where accounting comes in. There are various methods of estimating depreciation, all based on an assumed life of the element of the property to be depreciated. If the "straight line" method is used, that is to say, if the depreciation is supposed to be uniform each year, and the fund is accumulated on this basis, it should be so figured in the valuation. If the "sinking fund" method is required, then this method should be figured in the valuation.

The above consideration clearly demonstrates, it seems to me, the following propositions:

1. In making a valuation of a public utility property, accrued depreciation should not be deducted from the value new, unless a depreciation fund has been accumulated, in which case the depreciation for the elements covered by said fund, computed in the same manner in which the fund has been computed, should be deducted. The fund will be among the assets, and the depreciation which it represents should properly be deducted from the value new.

2. While in the case of some public utility properties, like gas and electric light plants, it may be wise in the public interest to permit, encourage, or even to require the company to accumulate a depreciation fund, permitting it, of course, to charge rates which will enable it to do so; yet in the case of a railroad, with its great multiplicity of elements, the accumulation of a depreciation fund in general is undesirable and unnecessary in the public interest, and results in a return by the public of a part of the capital to the company, to constitute a useless and permanent fund.

The case is different where there is overdue or deferred depreciation; that is to say, where renewals which were necessary

to maintain the property in good operating conditions *have not been made*. The company when it accepts its franchise, accepts the obligation to maintain the property in serviceable working condition. It must do this out of earnings, without increase of capital unless improvements are made. If it neglects to make necessary renewals in kind, excessive or overdue depreciation results, and this it is proper to deduct from the value new in order to find the present value, but only this. This represents what a purchaser would have to pay if he were buying the property, in addition to what he pays for the property to the previous owners, in order to put it into good workable condition; and he should, therefore, pay that much less than what would be its present value if in good workable condition.

If a railroad is properly maintained, with no overdue depreciation, it is just as valuable an operating concern as if it were new. The owner is under obligation to replace worn out parts in kind when they become worn out, without increase of the capital. Furthermore, the railroad as a whole never wears out if properly maintained. Its life is indefinite. If the accrued depreciation for individual items is added together it results in an accrued depreciation for the entire property. We have, therefore, let us say, ties on the average one-half worn out, because one-half of their life has elapsed, showing a present value of 50 per cent of the value known, and similarly for other elements. We have, then, the entire property showing a depreciation of perhaps 15 per cent. All of these depreciations for individual elements are worked out by one method or another from life tables, that is to say, from tables based on the assumed life of the various elements; and by adding these together the result is a depreciation in the value of the entire property as a whole. How can there be a depreciation based on the life of a property and the portion of it which has elapsed, if it has no determinable life, that is, if its life is indefinite? The property as a whole, if properly maintained, does not depreciate. A tie on a railroad may depreciate, but *the* ties of a railroad, if properly maintained, never depreciate. A tie has a life of ten years, therefore if it is five years old it has depreciated 50 per cent. *The* ties of a railroad, if properly maintained, have an indefinite life. Based on this, therefore, they have no depreciation if five years of their life

has elapsed. The property which is valued is *a railroad*, not a part of *a railroad*.

Furthermore, it is clear that no depreciation should be deducted from the value new of a properly maintained railroad property when it is considered how that property in its depreciated condition could be reproduced. The only way to reproduce it would be to reproduce it new, operate it, and get it into its present condition, in which case the cost of this process would be the cost of reproducing it new. It could not be reproduced with depreciated materials. If the value of a property is the cost of reproducing it in its present condition, then the value of a railroad property properly maintained is the cost of reproducing it new.

The company is always subjected to the obligation of making replacements in kind out of earnings as they become necessary. If it cannot do this and is a distinctly losing venture then reorganization may be necessary, with reduction of its capital and fixed charges; but so long as it has the credit to borrow money to make necessary renewals when they become due it should be allowed to do so, since it will have to pay the interest on this borrowed money as well as to make the renewals.

I believe that opinion is beginning to change with reference to the propriety and fairness of deducting depreciation from value new. Members of the Massachusetts Railroad Commission severely criticized several years ago a report which the writer made in which he advocated making no such deduction, and it is, therefore, all the more interesting to find that the chairman of that Commission has recently made the following statement:

In the matter of depreciation, so far as it has been a matter of discussion by the Public Service Commission of this State, in the various decisions which it has rendered, it has come before us in a double aspect. The problem which confronted the Commission in the first instance was to determine just what recognition should be given to accrued depreciation, in determining the fair value of the property upon which the company is entitled, under the law, to a fair return. The Commission was faced with that problem shortly after its organization, in the Middlesex and Boston rate case. The Commission in that case began, for the first time in this State, to exercise supervisory rate-making powers. It was natural, therefore, that it should examine the precedents in Commission and court decisions, throughout the rest of the country, in determining the basis which it should use in determining fair value for rate-making purposes.

Depreciating Investment

We found that throughout the country at large, the theory which had received recognition, far and away beyond any other theory; that had almost become crystallized into a legal rule, was the rule that a return should be allowed only upon the value of the property, less depreciation. That is to say, if you had a property with a value new of \$10,000,000 and if it was in the normal service condition of 75 per cent, the company would be entitled to a return on only seven millions and a half, although it might have ten millions of securities outstanding, which were issued under public supervision in this State.

The Commission did not believe that rule was sound or just to the men who had put their money into the properties. It did not believe, further, from an examination of the public utility field, that the application of any theory of that kind could be enforced without risking the practical bankruptcy of a large number of the street railway companies in this State.

The consequence was that the Commission adopted the theory that if this money was honestly invested in the properties in the first instance, and that they were maintained with anything like a decent degree of maintenance, that the companies and the investors were not to be penalized, in the absence of mismanagement, for any depreciation of the property that had been brought about in the public service, unless it could be shown that the company had profited from that situation, rather than the car-riding public.

The study of this subject, like the study of most subjects that are largely of an economic character, is interesting as a study of human nature. It discloses to us some of the virtues and many of the weaknesses and prejudices of humanity. If we are, ourselves, unprejudiced and open to conviction it perhaps makes us more tolerant and charitable toward those who differ from us in opinion, but it must convince us of the truth of the striking statement of Lecky, who says in one place :

Strange veins of insanity and capacities for enthusiastic folly sometimes flaw the strongest brains, and the impetuous ebullitions of youth which impel some men in extravagances of vice impel other natures into equally wild extravagances of thought.

and in another place :

There is such a thing as an honest man with a dishonest mind. There are men who are wholly incapable of deliberate willful untruthfulness, but who have the habit of quibbling with their convictions and by skillful casuistry persuading themselves that what they wish is right.

At all events it should make us more careful and moderate in forming our own opinions and more tolerant of differences of opinion, if coming from men whom we personally respect, whose motives we do not question, and who express their criticisms and differences with courtesy and kindness rather than with malignity.

Finally, it seems to the speaker that there is one portion of the decision of the Supreme Court in the Knoxville case which has not been quoted or regarded so extensively as it deserves to be. It indirectly recognizes the fact that the property of the public service corporation is private property. It reads as follows:

Our social system rests largely upon the sanctity of private property, and that State or community which seeks to invade it will soon discover the error in the disaster which follows. The slight gain to the consumer, which he would obtain from a reduction in the rates charged by public service corporations, is as nothing compared with his share in the ruin which would be brought about by denying to private property its just reward, thus unsettling values and destroying confidence.

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